Economies of Scale, Technical Progress and Regional Growth Disparities: Indian Industry, 1959-98

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This paper is an attempt to explain regional disparities in India's industrial growth using the theoretical framework on economies of scale, technical progress and cumulative growth differences. The paper finds that among Indian States, some, particularly the western States, have achieved fast output growth and, consequently, realized economies of scale; technical progress too has been rapid in these States. They have moved ahead in India's factory sector, leaving some other States, particularly the eastern States, farther behind. Thus a cumulative cycle of regional differences arises in India's industrial growth, in which realisation of scale economies is increasingly becoming an important determinant.

Key words: Economies of scale, technical progress, regional disparities, Indian industry
JEL classifications: E12, L60, O12, R11

1. Introduction

Even after five decades of planned development, industrial activities in India have not dispersed much across the various regions of the country. During the entire period 1959-60 to 1997-98, the two western States of Maharashtra and Gujarat have dominated Indian industry. These two States together, account for a share of approximately 34 per cent in the total value added by the country's factory sector. On the other hand, the eastern States of West Bengal, Bihar and Assam have been continually losing their prominence. West Bengal's share in value added by India's factory sector declined from 20 per cent in 1959-62 to 5.3 per cent in 1995-98. Some States lying in the northwest and central regions of the country including Madhya Pradesh, Rajasthan and Uttar Pradesh have significantly increased their shares in the country's factory sector, as did the three southern States of Andhra Pradesh, Tamil Nadu and Karnataka (see Table 1). This paper is an attempt to explain such regional disparities in India's industrial growth.[1]

I argue in this paper that the above-discussed regional disparities in India's industrial growth are due to a cumulative cycle of growth differences, which arise because of regional variations in the realization of economies of scale and in technical progress. The next section is a theoretical discussion on economies of scale, technical progress, and cumulative cycle of

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[1] See also Thomas (2002) for details on regional variations in India's industrial growth during the 1980s and 1990s.

regional growth differences. Section 3 discusses the Indian experience, and section 4 concludes the paper.

Table 1. *Shares of different States in gross value added (at constant 1981-82 prices) by India's factory sector, 1959-62 to 1995-98 (three-year averages in per cent)*

	1959-62	1969-72	1979-82	1988-91	1995-98
Maharashtra	25.71	25.69	23.46	22.65	21.86
Gujarat*	10.21	8.65	9.40	9.17	11.83
West	35.92	34.34	32.86	31.82	33.69
Tamil Nadu*	7.76	9.61	9.88	10.88	9.66
Andhra Pradesh*	3.13	4.12	5.01	5.66	6.90
Karnataka*	3.47	5.50	5.01	5.04	5.45
Kerala	2.73	3.17	3.09	2.65	2.03
South*	17.09	22.40	22.99	24.23	24.05
Uttar Pradesh*	6.07	6.70	7.60	9.33	9.13
Punjab*	2.65	2.23	3.29	3.93	3.21
Rajasthan*	1.03	2.04	2.85	2.89	3.12
Haryana*	0.00	1.59	2.98	2.92	3.44
North-West*	9.74	12.55	16.73	19.07	18.90
West Bengal	20.03	13.93	9.78	5.75	5.30
Bihar	7.97	5.88	6.06	6.01	4.73
Assam	3.17	1.38	1.15	1.43	0.80
East	31.17	21.18	17.00	13.19	10.84
Madhya Pradesh*	2.35	3.96	4.97	5.60	6.01
Orissa*	1.17	248	1.90	2.68	2.10
Central East*	3.52	6.44	6.86	8.28	8.12
Himachal Pradesh*	0.12	0.31	0.57	0.68	0.70
Jammu & Kashmir*	0.10	0.10	0.20	0.12	0.11
North*	0.22	0.42	0.78	0.80	0.81
India	100	100	100	100	100
Measures regional concentration					
Share of top 3 States %	55.95	49.23	43.12	42.86	43.35
Herfindahl Index	0.139	0.120	0.105	0.101	0.100

Notes: States arranged by their geographical location. The total shares of each geographical region are also given.

States and regions marked with an asterisk have increased their shares in total value added by India's factory sector between the two three-year periods, 1959-62 and 1995-98

Herfindahl index, which is used as a measure of concentration, is of the form $\sum s_i^2$, where s is the share of the ith State in total value added in the country. The index takes values in the range of 0 to 1. A value of 0 indicates zero concentration and a value of 1 indicates maximum concentration. See Gollop and Monahan (1991), pp. 318-21 and Chakravarty (1995), pp.15-25 for details.

Source: Annual Survey of Industries (ASI), results for factory sector, various issues

2. Economies of scale, technical progress and regional growth differences: a theoretical discussion

2.1 Economies of scale

Economies of scale or increasing returns are said to exist in production when an increase in inputs in the production process leads to a more than proportionate increase in output. Economies of scale can be achieved at the level of plants and firms, and at the level of an industry as a whole. Unlike economies of plant scale[1], economies of industry scale is a macro-phenomenon: that is, economies due to the emergence of new processes, new subsidiary industries or inter-branch specialization within manufacturing (Salter, 1960, pp. 140-142; Bairam, 1987); or economies due to which a general industrial expansion benefits all industries because each of them are part of "an interrelated whole"(Young, 1928, pp. 538-9 cited in Kaldor, 1966).

The idea of increasing returns first came from Adam Smith: by means of his famous pin-making example, Adam Smith illustrated how specialization or division of labour could lead to lower unit costs. In his account of "where economic theory went wrong," Kaldor (1972) says that, from the middle of the fourth chapter of Vol. I of the *Wealth of Nations,* Adam Smith abandoned the assumption of increasing returns for the assumption of constant returns, as did neo-classical general equilibrium theory in subsequent years.[2] In a classic paper in 1928, Allyn Young revived the notion of increasing returns (see Blitch, 1983). Economists who challenged general equilibrium theory, including Nicholas Kaldor, Gunnar Myrdal and Albert Hirschman revived it again; the assumption of increasing returns reappears in the most recent endogenous growth theories as well.[3]

The size of the market is an important determinant of the realization of economies of scale; as Adam Smith famously said, the "division of labour is limited by the extent of the market" (see Kaldor, 1972). Early studies on Indian industry point out that the small size of the domestic market led to uneconomic scales of operation in a number of industries (See, for instance, Chandrasekhar, 1987 and Narayana et al., 1992).

How do economic forces operate if economies of scale exist and if demand is price elastic? Young (1928, p.533, cited in Kaldor, 1972) wrote that "change [in the presence of economies of scale] becomes progressive and propagates itself in a cumulative way"; or, in Myrdal's (1957) formulation, "circular and cumulative causation" characterises the process of economic growth. The following illustration elaborates the point. Consider that there has been an autonomous increase in demand for product *x,* which is met by production of *x* on

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[1] On economies of plant scale, see Robinson, 1931, pp 29-31; Chandler Jr., 1964, pp. 23-49; Kaldor, 1972; and Chandler Jr., 1990, pp.21-28.

[2] According to Hahn and Mathews (1964), neoclassical theory largely ignored the existence of increasing returns because of the difficulty in fitting that into the prevailing framework of perfect competition and marginal productivity factor pricing.

[3] See Thirlwall (1999, pp.82-86) for a useful over view of the theoretical development of the notion of increasing returns. See Buchanan and Yoon (eds.) (1994) for a collection of essays on increasing returns

a larger scale. This leads to reduction in unit production costs and, therefore, the price of *x,* owing to the existence of economies of scale. Because prices have fallen and demand is price elastic, the demand for *x* further expands, leading to a cumulative cycle of growth. The cycle may not end here: increase in demand for *x* can generate increases in upstream or downstream demand.[1]

A cumulative cycle of the kind illustrated above is seen mostly in manufacturing or other secondary sector activities because of two important features of these activities. The first is the decline in unit production costs (or increase in labour productivity) as production expands to a larger scale following an increase in demand. This positive association between rate of growth of labour productivity and rate of growth of output has formally been stated in Verdoorn's law. The second is the price elasticity of demand, which causes demand to expand further as prices decline (Thirlwall, 1983).

2.2 Technical progress[2]

In the traditional neoclassical approach, the contribution of technical progress to output growth is the 'residual' after accounting for the contributions made by labour and capital; it proceeds independently of capital accumulation. However, those who are identified with the "vintage approach" or the notion of embodied technical progress, including Nicholas Kaldor and W E G Salter, argue that there exists a two-way relation between capital accumulation and technical progress.[3] To quote Kaldor: "The use of more capital per worker…inevitably entails the introduction of superior techniques, which require 'inventiveness' of some kind" (Kaldor, 1957, p. 595). To quote him again on the inverse relationship: "Most, though not all, technical innovations which are capable of raising the productivity of labour require the use of more capital per man" (*ibid.*). Fresh capital accumulation that embodies new machines is thus the vehicle for technical progress (Hahn and Mathews, 1964, pp. 832-8).

Output growth has an important role in determining the rate of capital accumulation: according to Kaldor (1972, p. 392).), "capital accumulation can always be speeded up -- or rather it automatically gets speeded up, with a faster growth of production."[4] Thus expansion of output helps not only to realize potential economies of scale but also to accelerate technical progress.

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[1] This illustration is taken mainly from Dixon and Thirlwall (1975) and Thirlwall (1999, pp.85-86).

[2] For standard surveys of the literature on technical progress, see Hahn and Mathews (1964) and Bramall (2000, ch.4, pp.108-121).

[3] For a good discussion on technical knowledge, see Salter, 1960, ch.2, pp. 13-26. See also his pp. 132-135 on technical change.

[4] Also see Kaldor (1970) on how capital accumulation does not initiate but proceeds along with economic growth (reprinted in Targetti and Thirlwall (eds.) 1989 pp. 336-39).

The relation between output expansion and technical progress comes out more clearly in the models of "learning by doing", first developed in the works of Kaldor (1957) and Arrow (1962).[1] According to this model, improvements in technique occur with the passage of time, as the product of experience. The higher the production of a commodity, the greater the opportunities for learning, and the faster technical progress. Knowledge gained from working on a large scale is not forgotten if the scale is reduced later; such economies are therefore irreversible. Kaldor and Mirrlees' (1961-2) treatment combined the learning and vintage approaches to technical progress. According to them, technical progress has two elements: "an exogenous increase in ideas, and the extension and exploitation of these ideas by learning." The latter requires continuous investment, but there are limits to the exploitation of ideas through investment alone (Hahn and Mathews, 1964, pp. 844-50).

2.3 Cumulative cycle of regional growth differences

Triggered by economies of scale and induced technical progress, a "polarization process" sets in between regions (countries or States within a country) that engage in trade of manufactured goods, with a few regions increasingly gaining advantages over others. Studies by Myrdal (1957), Kaldor (1966, 1970, 1972, 1981), and Dixon and Thirlwall (1975) have dealt with this problem. As Kaldor (1981) noted, this "polarization process" cannot be explained by neoclassical theory, but only by Keynesian or Harrodian theory, according to which output growth is determined by demand, not constrained by the supply of resources (not even of capital, because capital is generated as part of output growth).

In an industry where potential economies of scale exist, it becomes increasingly difficult for other regions successfully to compete with a region that already possesses some initial advantages. Output expands faster in the latter region. With this, productivity grows rapidly (because of the positive Verdoorn relationship between output and productivity growth), unit production costs decline rapidly, and capital accumulation and induced technical progress proceeds rapidly (because of the associations between capital accumulation and output growth and between technical progress and capital accumulation). The market share of the region in the industry further increases, leaving other regions with declining shares.[2] Growth advantages in one major industry in a region might induce growth advantages to the whole industrial sector of the region because of the existence of "economies of macro scale" (Kaldor, 1970).

What are the processes that impel a cumulative cycle of regional growth differences? First, as Dixon and Thirlwall (1975) argue, the degree of association between productivity

[1] See Salter, 1960, p. 142 and also pp.48-65 on how output expansion helps technical progress.
[2] This discussion has drawn from the model given by Dixon and Thirlwall (1975, pp. 203-6)

and output growth, or the extent of potential scale economies, varies between industries. Secondly, regions differ in their industrial composition. A region gains in the cumulative cycle of growth differences if potential scale economies exist in the major industries that constitute its industrial sector, and the region possesses some advantages by means of which it can expand faster and exploit economies of scale in these major industries.

3. Evidence from Indian industry

3.1 Economies of scale: variations across industries

Industries differ widely in their *potential* economies of scale. To find potential economies of scale (or returns to scale) in the different two-digit industries, we estimated the ratio form of the Cobb-Douglas production function using pooled time-series cross-section data, pertaining to the factory sectors of 15 Indian States. The reference period was 1979-80 to 1997-98. The function takes the following form:

$$\log (V_{it}/L_{it}) = a + \beta \log (K_{it}/L_{it}) + (\alpha + \beta - 1) \log L_{it} + \lambda T \qquad (1)$$

where V refers to gross value added, L to labour (number of employees), K to capital, and T refers to time.

t = time period from 1979-80 to 1997-98

i = 15 Indian States

Increasing returns to scale exist if the estimated value of $(\alpha + \beta - 1)$ is positive and significantly different from zero.

It maybe noted here that there have been long-standing criticisms against estimating production functions at the aggregate macro-economic level -- that is, production functions of the kind we are estimating in this analysis. A production function is ideally a micro-economic concept and specifies a relation between output and input defined in physical units. It is argued that when a production function is estimated at the aggregate level with input or output defined in monetary values at constant prices, the estimated parameters of the production function will merely be capturing an underlying accounting identity, and will not reflect the underlying technology of the economy.[1] Nevertheless, this paper has used production functions at the aggregate macro-economic level for obtaining a basic understanding of the nature of industries and industrial sectors at the macro-level.

Results in Table 2 show that potential economies of scale exist in chemicals (30), rubber and petroleum products (31), metal products (33), machinery (35-6), and all the textile industries (23, 24,26). On the other hand, only constant returns to scale exist in food products (20-21), beverages and tobacco (22) and paper products (28).

[1] The criticisms against aggregate production function first appeared in Phelps Brown's (1957) paper in 1957. See Felipe and McCombie (2001) for a good summary of these criticisms.

In general, industries that exhibit increasing returns are geographically more concentrated than industries that do not. Geographical concentration is very high in chemicals (30), rubber and petroleum (31), metal products (34) and in transport equipment (37) – all exhibiting increasing returns to scale. In each of these industries, the two western States of Maharashtra and Gujarat form the region with the highest concentration of industrial activity: together, these two States account for 60 per cent of India's total production of chemicals, 40 per cent of rubber and petroleum, 43 per cent of metal products, and 34 per cent of transport equipment. On the other hand, food products or beverages and tobacco, industries that do not exhibit increasing returns, are geographically more dispersed. However, the rule does not always hold: wood, exhibiting increasing returns to scale, is regionally quite dispersed (see Table 2).

Table 2. *Two-digit industries in India's factory sector: returns to scale and regional distribution, 1979-80 to 1997-98*

Two-digit industries	Returns to scale (1979-98)	Share of each region in the total value added by the industry in India 1995-98 (in %)						Measures of regional concentration, 1995-98	
		West	South	North-West	East	Central-East	India	Share of top 3 States (%)	Herfindahl Index
Food (20-1)	Constant	26	31	26	9	6	100	44.4	0.101
Tobacco (22)	Constant	14	41	24	12	5	100	48.0	0.111
Cott. Textiles (23)	Increasing	26	47	13	3	8	100	60.8	0.170
Wool, Silk (24)	Increasing	35	11	31	2	13	100	50.1	0.117
Textile Prdts. (26)	Increasing	20	38	20	1	0	100	52.8	0.113
Wood (27)	Increasing	19	15	16	28	8	100	42.1	0.086
Paper (28)	Constant	30	33	16	7	6	100	45.1	0.103
Chemicals (30)	Increasing	60	16	13	3	4	100	68.3	0.199
Rubber (31)	Increasing	40	23	15	12	4	100	51.2	0.114
Minerals (32)	Constant	22	35	17	6	16	100	40.3	0.096
Metals (33)	Constant	17	18	11	29	24	100	53.8	0.132
Metal Pro. (34)	Increasing	43	23	19	6	5	100	53.6	0.167
Machinery (35-6)	Increasing	35	30	20	7	4	100	49.6	0.128
Transport (37)	Increasing	34	20	29	13	2	100	61.8	0.168
Other Manu. (38)	Constant	43	19	25	4	1	100	57.2	0.168
Electricity (40)	Constant	31	20	22	14	10	100	43.5	0.097
Repair Ser. (97)	Increasing	24	21	12	13	16	100	45.3	0.092
Total	Constant	34	24	19	11	8	100	43.4	0.100

Notes: See Appendix for a detailed description of two-digit industries. See Table 1 for the Indian States that fall under each geographical category.
See notes under Table 1 for details on Herfindahl index.
Two-digit industry groups according to National Industrial Classification (NIC) 1987
Source: ASI results for factory sector, various issues

3.2 Extent of cumulative cycle of growth differences: variations across industries

A cumulative cycle of regional (inter-State) growth differences comes into play in several industries in India, the extent of this cycle depending on potential economies of scale. In industries in which the cycle of growth differences exists, a few States enjoy autonomous increases in demand, a subsequent expansion of output, faster productivity growth and faster reduction in unit production costs. In these industries, the rank correlation across Indian States between rates of growth of value added and labour productivity is positive, and between rates of growth of labour productivity and wage share in output is negative. If capital accumulation is a consequence of output growth, as Kaldor (1972) suggested, a positive rank correlation is expected between rates of growth of value added and fixed capital stock. Finally, a negative rank correlation is expected between the growth of wage share in output and increase of the State's share in the total value added by the industry in the country.

The correlation coefficients and, therefore, the extent of cumulative cycle of growth differences vary across two-digit industries (see Table 3). The cumulative cycle of growth differences is evidently in operation in chemicals (30), machinery (35-36), transport equipment (37), cotton textiles (23), and to lesser extent in basic metals (33), and rubber and petroleum (31), all industries exhibiting economies of scale. On the other hand, the cumulative cycle of growth differences is much less apparent in food industries (20-21), beverages and tobacco (22) and leather products (29), all industries that do not exhibit economies of scale. The relation between the growth of wage share in output and increase of share in total value added in the country is negative, as expected, in all industries, with the notable exception of the food industry (20-21) and repair services.

Table 3. *Rank correlations between rates of growth across 15 Indian States, two-digit industries in India's factory Sector, 1979-80 to 1997-98*

	Rank Correlations between Rates of Growth of:			
	Value Added & Labour Productivity	Value Added & Fixed Capital Stock	Labour Productivity & Wage Share in Output	Wage Share in Output & change of share
Food products (20-21)	0.49*	0.60	-0.29*	0.10*
Beverages, tobacco (22)	0.75	0.34*	-0.16*	-0.11*
Cotton textiles (23)	0.73	0.81	-0.77	-0.50*
Wool, silk, etc. (24)	0.80	0.55*	-0.90	-0.35*
Jute textiles (25)	0.26*	0.14*	-0.26*	-0.2*
Textile Products (26)	0.61	0.86	-0.60	-0.11*
Wood products (27)	0.86	0.70	-0.08*	-0.18*
Paper products (28)	0.90	0.41*	-0.79	-0.65
Leather products (29)	0.31*	0.71	-0.36*	-0.00*
Chemical (30)	0.79	0.75	-0.72	-0.28*
Rubber & petroleum (31)	0.83	0.62	-0.16*	-0.17*
Non-met. Minerals (32)	0.37*	0.54	-0.44	-0.18*
Basic Metals (33)	0.81	0.65	-0.30*	-0.00*
Metal Products (34)	0.76	0.80	-0.49	-0.19*
Machinery (35-6)	0.84	0.67	-0.65	-0.42
Transport Eqpt. (37)	0.71	0.93	-0.68	-0.60
Other manufact. (38)	0.79	0.34*	-0.68	-0.63
Electricity (40)	0.36*	0.66	-0.37	-0.02*
Repair Services (97)	0.35*	0.86	-0.06*	0.05*
Factory sector	0.71	0.64	-0.84	-0.59

Notes: * Not statistically significant at 5 per cent level
Source: ASI results for factory sector, various issues

3.3 Economies of scale: variations across factory sectors of Indian States

Regions differ with respect to the shares of the two-digit industries that constitute their industrial sectors. Industrial sectors of regions that realize potential economies of scale in their constituent industries gain in the cumulative cycle of regional growth differences. They exhibit economies of scale, achieve faster technical progress, faster growth of productivity and increase their shares in the country's industrial output.

Returns to scale for the factory sectors in each of 15 Indian States is estimated from a Cobb-Douglas production function, using pooled time-series cross-section data, pertaining to 18 two-digit industries and to the time period from 1979-80 to 1997-98. The form of the function is as follows.

$$\log (V_{it}/L_{it}) = a + \beta \log (K_{it}/L_{it}) + (\alpha + \beta - 1) \log L_{it} + \lambda T \quad (2)$$

where V refers to gross value added, L to labour (number of employees), K to capital, and T refers to time.

i = two-digit industries

t =time period from 1979-80 to 1997-98

Results in Table 4 show that increasing returns to scale exist in the industrial sectors of Maharashtra, Gujarat and Tamil Nadu, and also of Rajasthan, Punjab and Madhya Pradesh. The factory sectors of the other States in this study are characterised by constant returns to scale.

The industrial sectors of Maharashtra, Gujarat, and Tamil Nadu are large; they respectively occupy the first, second and third position among 15 Indian States in respect of (descending) shares in total gross value added by India's factory sector. The major industries of these States are industries in which economies of scale exist: "chemicals" (industry groups 30 and 31 together) in Maharashtra and Gujarat, and "machinery" in Tamil Nadu. These States are able to realize the potential economies of scale in their major industries because they are large producers in these industries. For example, Maharashtra and Gujarat account for 31 per cent and 29 per cent respectively of India's chemical (30) production. The fact that the whole factory sectors of these States exhibit increasing returns is certainly influenced by the fact of increasing returns being realised by their major industries (see Table 4).

The above explanation does not hold true for Madhya Pradesh, Rajasthan and Punjab; but we shall discuss the case of Rajasthan and Madhya Pradesh again in a later subsection.

Table 4. *Factory sectors of Indian States: structure, relative importance in India, and returns to scale, 1979-98 (all shares are of gross value added (gva) and in per cent)*

Region	State	Structure of the factory sector		State's share in India		Returns to Scale (1979-98)
		Major industries*	Its combined share in the State (%) 1995-98	in total factory sector (%) 1995-98	in its major industries (%) 1995-98	
W	Maharashtra	Chemicals	33.8	21.9	31, 21	Increasing
	Gujarat	Chemicals	57.5	11.8	29, 19	Increasing
S	Tamil Nadu	Machinery	24.4	9.7	11, 13	Increasing
	Andhra Pradesh	Metals	26.3	6.9	15, 12, 5	Constant
	Karnataka	Machinery	31.2	5.5	11, 5	Constant
	Kerala	Chemicals	39.8	2.0	2, 5	Constant
NW	Uttar Pradesh	Chemicals	24.4	9.1	8, 10	Constant
	Haryana	Machinery	59.3	3.4	6, 16	Constant
	Punjab	Machinery	21.3	3.2	3, 4	Increasing
	Rajasthan	Textiles	21.8	3.1	3, 14, 0, 3	Increasing
E	West Bengal	Machinery	19.9	5.3	5, 5	Constant
	Bihar	Metals	52.2	4.7	2, 24, 1	Constant
	Assam	Chemicals	43.5	0.8	0, 4	Constant
CE	Madhya Pradesh	Metals	38.5	6.0	12, 18, 4	Increasing
	Orissa	Metals	35.7	2.1	3, 6, 1	Constant
	India	Chemicals	26.1	100	100, 100	Constant

Notes: States arranged by their geographical location: west (W), south (S), north-west (NW), east (E) and central-east (CE).

*'Major industries' is the industry category whose combined share in total value added is the highest among all categories of inter-related two-digit industry groups. The following are the different industry categories: two-digit industry groups 20-21 and 22 combined; 23, 24, 25 and 26 combined; 27,28 and 29 combined; 30 and 31 combined; 32, 33 and 34 combined; 35-36 and 37 combined; and 38,39,40,41,42,74 and 97 combined. The last category of industry groups was not considered in the choice of 'Major industries'. 'Chemicals' refers to industry groups 30 and 31 combined; 'Textiles' refers to industry groups 23, 24, 25 and 26; 'Machinery' to industry groups 35-36 and 37; and 'Metals' to industry groups 32, 33 and 34.

Under the column titled 'State's share in India in its major industries' are given each State's share in India in the two-digit industry groups that form its major industrial category. For example, the observation against Maharashtra – 31, 21 – indicates that Maharashtra's shares in the country in industry groups 30 and 31 are respectively 31 per cent and 21 per cent.

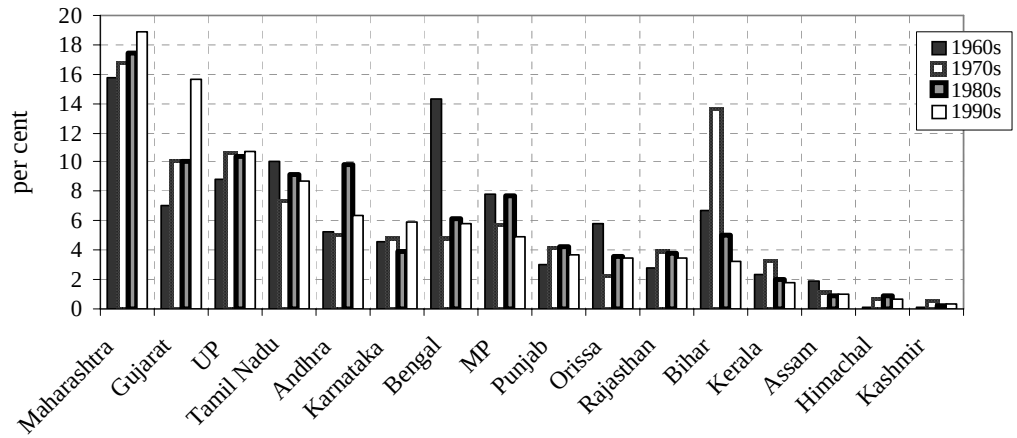
Source: Calculations based on ASI results for factory sector, various issues

3.4 Variation in technical progress across Indian States

Technical progress – as embodied in fresh capital investment -- has accentuated regional differences due to variations in the realisation of scale economies. Technical progress, measured by fresh capital investment, has been very fast in a few States, particularly Maharashtra, Gujarat, Uttar Pradesh and Tamil Nadu, while it has been slow in States such as Kerala and Assam. Fresh investment, as a share of the total investment in the country, is

increasing over the decades in Maharashtra and Gujarat, whereas it is declining in a few other States including West Bengal, Bihar, Kerala and Assam (see Figure 1).

Figure 1. *Shares of different States in total investment in India, factory sector, over the decades (in per cent)*



Notes: 1960s: 1959-60 to 1969-70, 1970s: 1970-71 to 1978-79, 1980s: 1979-80 to 1990-91, 1990s: 1991-92 to 1997-98. Investment is addition to fixed capital stock.

Source: ASI results for factory sector, various issues

Total Factor Productivity (TFP) growth rates in Indian States in each two-digit industry group have been estimated from the regression equation (1). TFP growth rate is the estimate of λ in the equation. In the regression equation, λ has been estimated separately for each of our 15 Indian States, using State-specific dummy variables. It may be noted here, however, that there are several criticisms against the use of TFP as a measure of technical progress.[1]

Results in Table 5 show that among 15 Indian States, technical progress measured by TFP growth has been the fastest in Maharashtra, in total factory sector as well as in several constituent two-digit industries. Tamil Nadu, Karnataka and Gujarat closely followed Maharashtra in TFP growth rate rankings. On the other hand, Bihar, Kerala, Assam and

[1] TFP is the residual after accounting for the contribution made by capital and labour to the growth of output. The major criticism against the use of TFP as a measure of technical progress originates from the 'Cambridge critique' -- from the fact that the measure of capital used in production function estimations consists of both physical quantity and price. Given such a measure of capital, even a change in relative prices, with no significant change in the physical quantity of capital, will be seen as a change in TFP – which is conceptually wrong. It is also argued that there is an inconsistency in suggesting that slow TFP growth is because of excess capacity or recession, because estimations of TFP assume full employment and perfect competition. See Fine (2003) for these criticisms. Felipe and McCombie's (2003) criticisms of TFP are related to problems with the aggregate production function, from which TFP is estimated.

West Bengal have had only very slow rates of TFP growth; TFP growth in Andhra Pradesh and Punjab too has been slow.

Table 5. *Rankings of Indian States in descending rates of Total Factor Productivity growth, in total factory sector and in constituent two-digit industries: 1979-80 to 1997-98*

Indian States	Two-digit Industry groups																	
	20-21	22	23	24	26	27	28	29	30	31	32	33	34	35-36	37	40	97	Total
Andhra Pradesh	10*	14*	9*	8*	14*	6*	5*	10*	9**	14*	8*	7*	12*	6**	15*	10**	10**	13**
Assam	6*	12*	7*	9*	6	7*	14*	11*	15	1	14*	11*	10*	15	9*	15	12**	12**
Bihar	13*	1	15	15	12*	8*	15	9*	14	11*	15	5*	14*	14	6	2	14**	15**
Gujarat	11*	13*	10*	14*	8*	10*	9*	13*	5**	2	11*	9*	11*	13	11*	4**	9**	4
Haryana	4*	8	6*	12*	2	1	6*	2	10**	8*	9*	10*	8*	7**	1	13	11**	8**
Karnataka	8*	3	5	2	10*	12	3*	6	8**	13*	2*	12*	4	3**	4	5**	4	3
Kerala	1	10*	2	3*	11*	15	4*	14*	7**	3	12*	3*	13*	9**	10*	9**	3	14**
Maharashtra	5*	11*	12*	11*	4	3*	1*	3	3**	4	10*	2*	3	1**	2	1	7**	1
Madhya Pradesh	12*	5	8*	1	15*	5*	13*	1	4**	12*	6*	4*	1	5**	5	11**	2	6
Orissa	15*	15*	13*	6*	13*	4*	10*	15	13	7*	3*	6*	15*	11**	8	14	5**	7
Punjab	2	4	1	13*	1	11*	7*	8	1	15	5*	8*	6*	12	13*	12	1	11**
Rajasthan	9*	6	4	10*	3	2*	12*	12*	2**	5*	4*	15	2	4**	3	8**	6**	9**
Tamil Nadu	3*	7	3	5*	9*	14	2*	5	12	6*	1	13	5	8**	7	6**	15**	2
Uttar Pradesh	7*	2	14	7*	7*	9*	8*	4	6**	9*	13*	1	9*	2**	12*	3**	13**	5
West Bengal	14*	9*	11*	4*	5	13	11*	7	11**	10*	7*	14	7*	10**	14*	7**	8**	10**

Notes: *TFP growth rates of these States are not significantly different from zero
**TFP growth rates of these States are not significantly different from each other
See Appendix for a full description of two-digit industry groups
Source: Calculations based on ASI results for factory sector, various issues

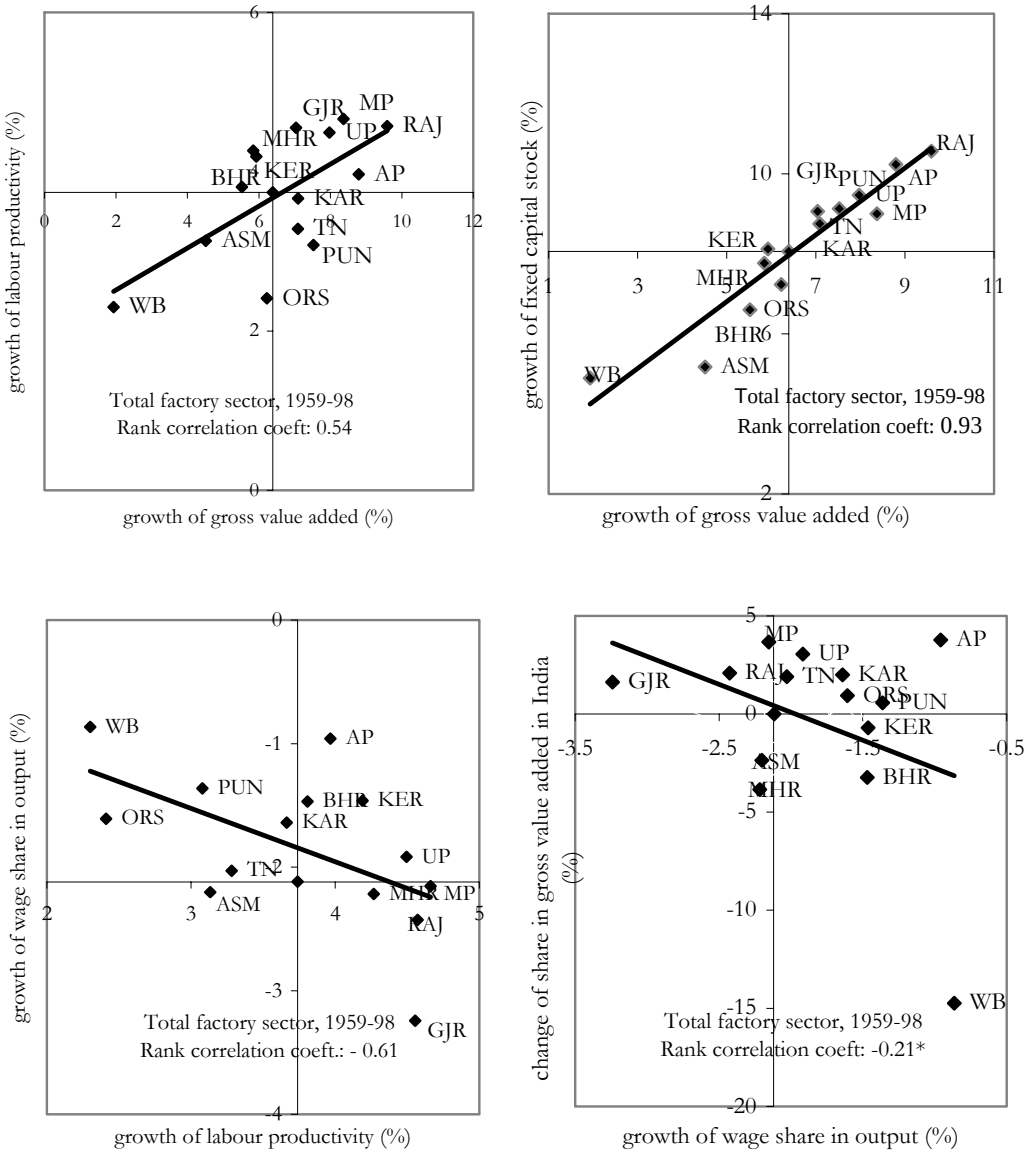
3.5 Cumulative cycle of growth differences: across factory sectors of Indian States

Because of variations in economies of scale and technical progress, some States achieve faster output and productivity growth and a faster reduction of wage share in output, while other States lose out.

As figure 2 illustrates, during the period 1959-60 to 1997-98, a few States particularly Uttar Pradesh (UP), Rajasthan (RAJ), Madhya Pradesh (MP) and Andhra Pradesh (AP) as well as Maharashtra (MHR) and Gujarat (GJR), which lie roughly in India's western and central region have gained in the growth cycle. Barring a few exceptions, expansion of industrial output in each of these States is faster than the countrywide average; so are labour productivity growth and capital accumulation. These States have reduced wage share in output in their factory sectors faster than the Indian average. Between 1959-60 and 1997-98, shares of all these States in India's factory sector have increased. Maharashtra's share declined slightly, but this should be more on account of the dispersal of industrial activities in this State to other neighbouring regions including Madhya Pradesh and Andhra Pradesh. In addition to their proximity to Maharashtra and Gujarat, Madhya Pradesh, Andhra Pradesh and Rajasthan have also gained from relatively faster power generation and availability of raw materials for chemicals, petrochemical and basic metal industries (Thomas, 2003).

On the other hand, the eastern States, West Bengal (WB), Bihar (BHR) and Assam (ASM), have lost out in this cumulative cycle. Barring a few exceptions, growth of value added, labour productivity and capital accumulation as well as reduction of wage share in output in these States are lower than the Indian average; and shares of these States in India's factory sector have fallen.

Figure 2. *Cumulative cycle of growth differences: rates of growth of gross value added, labour productivity, fixed capital stock and wage share in output, and change of share in India, total factory sectors of 14 Indian States, 1959-60 to 1997-98*



Notes: The origin of each of these scatter diagram coincides with the growth rate for India as a whole.
Source: ASI results for factory sector, various issues

3.6 Determinants of State-wise differences in growth of productivity and capital stock, decade-wise

The cumulative cycle of growth differences discussed above account for a substantial part of the inter-State differences in productivity growth and investment, increasingly so over the decades, as will be shown by the econometric exercises below.

Details of Econometric Exercises:[1] Labour productivity growth is regressed on growth of value added, growth of capital intensity and the log of capital intensity at the beginning of each time period. A positive and significant relation is expected between growth of labour productivity and value added because of the existence of economies of scale. Increase in labour productivity can also be due to increase in capital intensity – by the substitution of capital for labour, or the availability of more machines per worker.[2] The level of capital intensity in the base year is an indicator of the technological level of the State's industrial sector at the beginning of the study period. The higher this base technological level, the faster is the expected rate of growth of labour productivity.

Capital accumulation is an accompaniment of output growth, following Kaldor (1972). It is also possible that fresh investment favours regions that have larger industrial sectors, which will also have larger markets, better infrastructure facilities and other associated advantages. Taking account of both these factors, growth of capital stock is regressed on growth of value added and log of value added in the base year (proxy for the size of industrial sector).

This paper has attempted to estimate the determinants of differences between 15 Indian States with respect to the growth of productivity and capital stock separately for each of the four decades, 1960s, 1970s, 1980s and 1990s. Equations for each decade have been estimated together in a Seemingly Unrelated Regression (SUR) framework to account for the correlation of residuals across decades. Results are given in Tables 6 and 7.

Results: Results in Table 6 indicate that in India's factory sector, economies of scale, or the positive relation between growth of labour productivity and value added, was weak in the 1960s, but grew stronger in the subsequent decades. In the regression for labour productivity, the estimate of the coefficient for the growth of value added is not statistically different from zero in the 1960s, but not so in any subsequent decade. An

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[1] The econometric exercise in this paper has considered the issues raised in Kaldor (1966), Rawthorn (1975), Gomulka (1971), McCombie (1983), Bairam (1987), McCombie and Thirlwall (1994, pp.175-80), McCombie and de Ridder (1983), Fingleton and McCombie (1998), Harrice and Lau (1998) and Chatterji and Wickens (1983).

[2] According to Salter's (1960) study, factor substitution was a factor -- along with economies of scale and technical progress -- that accounted for differences in productivity growth across British industries. According to Hahn and Mathews (1964, p. 840), productivity per man depends on capital intensity of all the machines in use and on their average age.

increase in value added growth by 1 per cent is associated with increases in labour productivity growth of 0.4 percent in the 1970s, 0.8 per cent growth in the 1980s, and 0.6 percent growth in the 1990s. Capital-labour substitution, or the availability of more machines per worker, has been an important determinant of labour productivity growth in all the decades, and particularly in the 1980s, when a 1 per cent increase in growth of capital intensity was associated with a 1.1 per cent increase in the growth of labour productivity. The variable, log of capital intensity in the base year, is not statistically significant in any of the decades. However, the negative sign of the coefficient in the 1960s and positive sign in the later decades indicate that a low initial level of capital intensity was not associated with a rise in productivity growth in the 1960s, but was associated with productivity growth in subsequent decades.

Results in Table 7 indicate that output growth has been a significant determinant of investment in all the four decades, and more so in the 1990s. A 1 per cent increase in the growth of value added is associated with a 0.6 per cent increase in the growth of capital stock in this decade. The coefficient for log of value added in the base year is negative in the 1960s and 1990s (it is significant in the 1960s), but positive in the 1970s and 1980s. Thus, while investment moved to smaller industrial sectors in the 1960s, such a process did not occur in the 1970s and 1980s, although it did recur in the 1990s.

The realisation of economies of scale has become increasingly important over the decades as a determinant of productivity growth in India's industrial sector. This implies that regions (or States) where advantages came to be built up in the initial decades of India's planned industrialization by means, for example, of larger amounts of public investment, have exploited these advantages in later decades through the realization of economies of scale. Other regions, which did not begin with such advantages, lost out further in the 1980s and 1990s, in the cumulative cycle engendered through economies of scale. The pattern of industrial investment in the country, which favoured larger, and not smaller, industrial sectors, has only reinforced these inter-regional growth differences.

India's western region had important advantages over other regions in the country with respect to industrial growth. These advantages increased over the years. They include historical advantages such as the early emergence of an entrepreneurial class (Bharadwaj, 1982); investment preferences shown by oligopoly business houses in the country[1]; favourable treatment under the licensing regime that guided investment decisions in the country for several long years (Banerjee and Ghosh, 1988); relatively large shares of disbursements by central-government financial institutions (Gulati and George, 1978) and

[1] On the oligopoly power of business houses see Hazari, 1966; Ghose, 1974a ; Ghose, 1974b; and Chandrasekhar, 1988.

even of disbursements by state-led financial assistance schemes aimed at regional dispersal (Das, 1993, Srivastava, 1994); and faster rates of public sector investments in power and petrochemicals after the late 1970s (Thomas, 2003). Such differences in initial advantages helped States located in the western and adjoining areas in the country to realize potential scale economies and move ahead with respect to the cumulative cycle of growth differences, and caused the eastern States, to fall behind.

Table 6. *Determinants of productivity growth during different decades in India's factory sector: results from a Seemingly Unrelated Regression using a panel of data of 15 Indian States and 4 decades (dependent variable: growth of labour productivity)*

Variable	1960s	1970s	1980s	1990s
Intercept	-1.927	-4.674	-13.753	-6.942
	(-0.37)	(-0.95)	(-1.66)	(-0.54)
Growth of value added	0.204	0.423***	0.822***	0.662***
	(1.69)	(4.50)	(4.98)	(4.36)
Growth of capital intensity	0.637***	0.339***	1.138***	0.790***
	(3.15)	(3.99)	(5.03)	(5.16)
Log of capital intensity, base year	-0.935	0.602	1.243	0.351
	(-0.79)	(0.60)	(0.80)	(0.16)

Notes: Coefficient is top number in each cell. t-ratio is given in parenthesis. ***significant at less than 1% level; **significant at less than 5% level; *significant at less than 10% level
1960s is 1959-60 to 1969-70, 1970s is 1970-71 to 1978-79, 1980s is 1979-80 to 1990-91, and 1990s is 1991-92 to 1997-98.
A cross-section data of 15 Indian States is used in the regression for each decade. The regression equations for the four decades are estimated together using Seemingly Unrelated Regression (SUR). System weighed R^2 = 0.8585. There are no observations for Haryana for the decade of the 1960s.
Source: Calculations based on ASI results for factory sector, various issues

Table 7. *Determinants of investment (fixed capital stock growth) during different decades in India's factory sector: results from a Seemingly Unrelated Regression using a panel of data for 15 Indian States and 4 decades (dependent variable: growth of fixed capital stock)*

Variable	1960s	1970s	1980s	1990s
Intercept	25.652**	-1.952	-4.018	9.173
	(3.08)	(-0.17)	(-0.47)	(0.71)
Growth of value added	0.502***	0.471*	0.439*	0.612*
	(3.88)	(2.12)	(2.86)	(2.94)
Log of value Added, base year	-1.453*	0.517	0.725	-0.502
	(-1.91)	(0.53)	(1.04)	(-0.44)

Notes: see Table 6; System weighed R^2 = 0.6736.
Source: *Calculations based on ASI results for factory sector, various issues*

4. Conclusions

This paper was an attempt to explain regional disparities in India's industrial growth using the theoretical framework on economies of scale, technical progress and cumulative growth differences. Economies of scale -- a possibility that productivity grows fast and

unit production cost declines as production expands to a larger scale –exist in several industries in India, but not in all. Maharashtra and Gujarat, which account for large shares in India's industrial output, and also some other States in their geographical vicinity including Madhya Pradesh and Rajasthan have realized scale economies in industries where potential scale economies exist. Also, technical progress, measured by fresh capital investment or TFP growth, has been faster in these States. These States have achieved faster output growth and productivity growth, faster reduction of wage share in output, and enlarged their shares in India's factory sector, leaving a few other States, particularly the eastern States of West Bengal and Bihar, farther behind. Analysis showed that, over the decades, realisation of scale economies has increasingly been an important determinant of productivity growth in India's factory sector; and that industrial investments in the country have been moving to larger, and not smaller, industrial sectors (at the State level). The western States, which began with initial advantages over the eastern States, further built on their advantages by realisation of scale economies and faster induced technical progress.

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Appendix

This study has used data on India's factory sector obtained from Annual Survey of Industries (ASI), conducted since 1959 and published by the country's Central Statistical Organization (CSO). Factory sector consists of all registered factories, that is, factories that employ more than ten workers with the aid of power and more than twenty workers without the aid of power. Data on gross value added (which is the sum of net value added and depreciation), total output, total number of persons employed and total emoluments have been used in this study. A fixed capital stock series at constant prices was obtained from book value of capital reported in ASI, using perpetual inventory accumulation method.[1] Relevant wholesale price indices with base 1981-82 have been used to deflate value figures.

In this paper, labour productivity is defined as gross value added divided by number of persons employed; capital intensity as fixed capital stock divided by number of persons employed; and wage share of output as total emoluments divided by total output.

All growth rates used in this paper are calculated using semi-logarithmic regression.

In the estimation of production functions and TFP, ASI data on 18 two-digit industry groups, for which consistent State-wise, time-series data are available, has been used. Given below is a complete list of all major two-digit industry groups and their description according to National Industrial Classification (NIC) 1987:

20-21:Manufacture of Food Products; 22: Manufacture of Beverages, Tobacco and Related Products; 23 Manufacture of Cotton Textiles; 24: Manufacture of Wool, Silk and Man-Made Fibre Textiles; 25: Manufacture of Jute and other Vegetable Fibre Textiles (Except Cotton); 26 Manufacture of Textile Products (including Wearing Apparel); 27 Manufacture of Wood and Wood Products, Furniture and Fixtures; 28 Manufacture of Paper and Paper Products and Printing, Publishing and Allied Industries; 29 Manufacture of Leather and Products of Leather, Fur and Substitutes of Leather; 30: Manufacture of Basic Chemicals and Chemical Products (Except Products of Petroleum and Coal); 31 Manufacture of Rubber, Plastic, Petroleum and Coal products, and Processing of Nuclear Fuels; 32 Manufacture of Non-Metallic Mineral Products; 33 Basic Metals and Alloys Industries; 34 Manufacture of Metal products and Parts, except Machinery and Equipment; 35-36: Manufacture of Machinery and Equipment other than Transport Equipment; 37: Manufacture of Transport Equipment and Parts; 38 Other Manufacturing Industries including Manufacture of Scientific Equipment, Photographic/

[1] See Thomas (2003) for details

Cinematographic Equipment and Watches & Clocks; 39 Repair of Capital Goods; 40 Electricity; 97 Repair Services

This study has extensively used State-wise data of the ASI. The following 15 Indian States have been considered for the study: Andhra Pradesh, Assam, Bihar, Gujarat, Haryana, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Orissa, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh and West Bengal. Data on Haryana is available only from the year 1970-71 (this State was formed later), and has not been used in Figures 1 and 2. Jammu and Kashmir, Himachal Pradesh and several other States, whose industrial sectors are small and consistent data on which are not available, have been excluded. Given below is a map of India showing all the States in the country (this map was drawn before the recent addition of new Indian States).